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Indian Standard

SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC RF MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

UDC 621·317·725 : 621·38 : 621·317·3

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SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC RF MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

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Indian Standard

SPECIFICATION FOR DIRECT READING POINTER INDICATOR TYPE AC ELECTRONIC RF MILLIVOLTMETER

PART I METHODS OF MEASUREMENTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 17 September 1979, after the draft finalized by the Electronic Measuring Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part I) covers methods of measurements of characteristics of ac electronic RF millivoltmeters of direct reading pointer indicator type operating up to 1 000 MHz. Part II of this standard covers performance requirements.

0.3 This standard lays down a single method of measurement for each characteristic so as to achieve the required degree of accuracy. It is not, however, intended to exclude other alternative methods of measurement for which necessary measuring equipment may be available and which are of equal or greater accuracy than the method prescribed in this standard.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) prescribes the conditions and detailed procedures for the measurement of performance characteristics of direct reading pointer indicator type ac electronic RF millivoltmeter operating up to 1 000 MHz.

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*Rules for rounding off numerical values (*revised*).

1.1.1 This standard applies to complete apparatus only and not to the component parts thereof.

1.1.2 This standard does not cover digital type electronic voltmeter.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following and the definition and explanations of terms given in **2** of IS : 3437-1972* shall apply.

2.1.1 *Input Voltage Standing Wave Ratio* (*VSWR*) — The ratio of voltage maximum to voltage minimum of a standing wave on a transmission line.

3. GENERAL CONDITIONS FOR MEASUREMENTS

3.0 Unless otherwise specified measurements shall be made under normal measuring conditions as specified in **3.1** to **3.4**.

3.1 Normal Supply Voltage — Rated supply voltage shall be applied to the electronic voltmeter.

3.1.1 The voltage applied to the electronic voltmeter shall be held constant within 1·0 percent of the rated value during the measurement of the characteristics.

3.1.2 In case of ac mains operation, the voltage shall be applied at the rated frequency. The harmonic content of ac mains supply voltage shall not exceed 5·0 percent.

3.1.3 In case of battery operation, primary or secondary batteries of the type and rated voltage as specified by the manufacturer shall be used.

3.2 Standard Atmospheric Conditions for Tests

3.2.1 Unless otherwise specified, all tests shall be carried out under the following atmospheric conditions:

Temperature	15 to 35°C
Relative humidity	45 to 75 percent
Atmospheric pressure	86 to 106 kPa

3.2.1.1 Where the conditions mentioned in **3.2.1**, have a significant influence, these shall be kept substantially constant during the tests.

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*General requirements for direct reading pointer indicator type electronic voltmeter (*first revision*).

3.2.2 For specific tests which are considered dependent on atmospheric conditions the tests shall be conducted, and in case of doubt, the tests shall be repeated, at temperature of 25 ± 1°C and relative humidity of 65 ± 2 percent [*see* IS : 9000 (Part I)-1977*].

3.2.3 The electronic voltmeter shall be protected from draughts and direct radiations.

3.3 Measurements

3.3.1 All measurements shall be made under the conditions mentioned in each clause.

3.3.2 *Preliminary Adjustment* — The index of the voltmeter having a mechanical zero shall be set to the appropriate mark on its scale. The supply voltage shall then be applied for a time equal to the warm-up time as specified by the manufacturer. In the absence of such information, this voltage shall be applied for a period of 15 minutes, or specified by the manufacturer. The electrical zero shall then be adjusted. All the other preliminary adjustments specified by the manufacturer shall be carried out. In making measurements, the mechanical zero shall not be altered, but the electrical zero should be re-adjusted before each measurement, if necessary.

3.3.3 Unless otherwise specified in the relevant clauses, all measurements shall be carried out within the measuring range.

3.3.4 Since the instrument under test is having high sensitivity and wider bandwidth, it is essential to take precautions against errors resulting from stray pick up voltages. A well shielded signal source shall be used in conjunction with coaxial connection to both the RF millivoltmeter under test and the standard reference meter.

3.4 Test Report — The test report shall clearly indicate the following:

a) Rated supply voltage and frequency in the case of ac,
b) Atmospheric conditions under which tests are carried out, and
c) Accuracy of test set-up.

4. ACCURACY

4.1 Accuracy of Voltage Range

4.1.1 The accuracy of different voltage ranges of the instrument shall be measured at least at three points, say, at 10 percent, 50 percent and 90 percent of full scale, on each voltage range at 1 MHz using the set up given in Fig. 1.

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*Basic environmental testing procedures for electronic and electrical items : Part I General.

4.1.2 Scale linearity shall be checked in the lowest basic range taking measurement for each major sub-divisions or 10 points.

4.1.3 Sinusoidal voltage at frequency of 1 MHz (obtained from a stable signal generator) shall be fed to the millivoltmeter under test. The amplitude of the input voltage shall be measured with an precision ac voltmeter having an acccuracy, preferably 10 times better and minimum 4 times better. Necessary corrections for the waveform distortion of the input signal may be made.

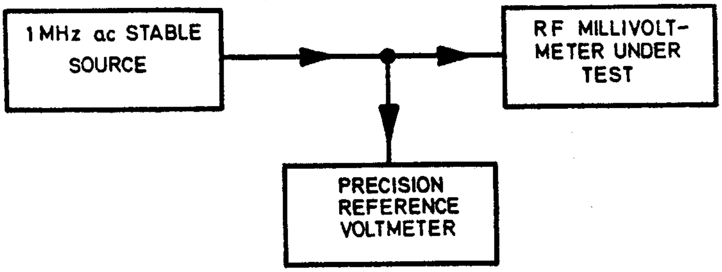

Fig. 1 Setup for Calibration of Voltage Ranges

4.1.4 From these measurements, the accuracy of the voltage range shall be computed at 1 MHz.

5. DEVIATIONS OF ELECTRICAL ZERO

5.1 Fluctuation — For each of the ranges, the fluctuations (random and spurious deviations) of the electrical zero shall be observed during any one minute period over a specified interval which shall be at least one hour with no input voltage applied after the preliminary adjustments. Maximum value of such deviation (fluctuation) shall be noted.

5.2 Drift — After the preliminary adjustments, the voltmeter shall be left in operation and the deviation from zero shall be observed during the time interval specified by the manufacturer. This should be at least one hour. The maximum value of this deviation (drift) shall be noted for each range.

5.3 Influence of Applied Input Voltage — After the preliminary adjustments, the electrical zero shall be adjusted on the highest range, that is, the least sensitive range. The voltage corresponding to this range shall be applied between the input terminals. After one hour, the input voltage shall be disconnected and the deviation of the electrical zero shall be noted.

5.4 Influence of Change of Range — After a change of range, the deviation of the electrical zero shall be recorded. These measurements shall be made in passing from each range to all the others having the same accuracy.

5.5 Influence of Supply Voltage Change

5.5.1 With no input voltage applied, the voltmeter shall be energized for a time (after the initial warm-up period) sufficient to ensure that the drift of electrical zero with time is negligible compared with deviation consequent upon the change of supply voltage. The electrical zero shall then be adjusted to the appropriate mark of the scale.

5.5.2 A sudden and sustained change of 5 percent (positive or negative) shall be made in the supply voltage. During a period of one minute immediately following this change, the maximum deviation of the electrical zero shall be noted. The test shall be continued with a second sudden and sustained change of 5 percent (superimposed on the first one and in the same direction).

5.5.3 At the end of the total period of 30 minutes or the warm-up time if longer, the final deviation of the electrical zero shall be determined.

5.5.4 The deviation of electrical zero shall be expressed as a percentage of the scale length.

5.5.5 The measurement shall be carried out both for positive voltage change and for negative voltage change.

5.6 Influence of Ambient Temperature Change

5.6.1 The influence of ambient temperature on the indications of the voltmeter shall be determined from measurements made at intervals of 5 ± 1°C within the nominal range. When no nominal range of use concerning the ambient temperature is indicated by the manufacturer, this range shall be between two limits respectively equal to 10°C above and 10°C below the reference temperature.

5.6.2 After the preliminary adjustments, the voltmeter shall be kept in operation under reference conditions. The temperature shall be varied in steps of 5°C and deviation of electrical zero shall be measured at each step after thermal equilibrium is reached at that temperature. From these measurements the total deviation of electrical zero over the specified temperature range shall be computed.

6. VARIATION IN INDICATION

6.1 Influence of Position — The influence of the position shall be determined for one of the ratings only. After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. With the voltmeter in reference conditions and also with the voltmeter inclined to its reference position by an angle of + 5 degrees in two perpendicular planes successively, the reading of the index shall be noted. When several reference positions are indicated, the voltmeter shall be tested in each of these positions. When no reference position is indicated, measurements shall be made with the voltmeter in the normal operating position and also in a position perpendicular to this operating position.

6.1.1 From these measurements the variation in indication shall be computed.

6.2 Influence of Ambient Temperature Change

6.2.1 The influence of ambient temperature on the indications of the voltmeter shall be determined from measurements made at intervals of 5 ± 1°C within the nominal range. When no nominal range of use concerning the ambient temperature is indicated by the manufacturer, this range shall be between two limits respectively equal to 10°C above and 10°C below the reference temperature.

6.2.2 After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals, the voltmeter being under reference conditions. The temperature shall be varied in steps of 5°C and the variation in indication shall be measured at each step after thermal equilibrium is reached at that temperature. From these measurements, the total deviation over the specified temperature range shall be computed.

6.3 Influence of Supply Voltage Change

6.3.1 With no applied measuring voltage, the voltmeter shall be energized for a time after warm-up period sufficient to ensure that the drift of electrical zero is negligible compared with the displacement of the electrical zero consequent upon the change of supply voltage. The electrical zero shall then be adjusted to the appropriate mark of the scale. A voltage equal to 90 percent of upper limit of the effective range shall then be applied between the input terminals the reading being noted; following which a sudden and sustained change of 5 percent (positive or negative) is made in the supply voltage. During a period of one minute immediately, following this change, without electrical zero adjustment, the maximum value of variation in indication shall be noted.

6.3.2 The applied input voltage shall then be removed and the test continued with a second step of 5 percent sudden and sustained change in the supply voltage superimposed on the first one in the same direction, for a further period to bring the total time of both variations to 30 minutes or warm-up time if longer.

6.3.3 The electrical zero shall then be re-adjusted, if necessary, the recalibration procedure (if any) carried out; the input voltage reapplied, and the final variation in indication determined.

6.3.4 The limits of permissible variation in indication shall be expressed as percentage of the scale length.

6.3.5 The measurement shall be carried out both for positive voltage change and for negative voltage change.

6.3.6 The measurement shall be carried out on each range.

6.4 Influence of Superimposed Input Voltage For Voltmeters Sensitive of Alternating Voltage Ranges — After preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. A direct voltage which is 1 000 times the rating of the range under test, this value being limited to the specified insulation voltage, shall be applied across the input terminals of the voltmeter. Deviation of the index after removal of the voltage shall be noted, from which the deviation of index due to superimposed dc voltage shall be computed. This test shall be carried out on each range of the voltmeter.

NOTE — A voltmeter containing a transformer or a semiconductor device connected to its input terminals shall not be tested with imposed dc voltages.

6.5 Fluctuations — After the preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. The fluctuations of the index (pointer) (the random and spurious deviations) shall be observed during one minute period over a specified interval. This shall be at least 30 minutes for ranges of 1 V or less, or one hour for other ranges. The maximum fluctuation occurring over a one minute period shall be noted.

6.5.1 The fluctuations shall be measured for each range.

6.6 Drift — After initial warm-up period and preliminary adjustments, a voltage corresponding to a steady deflection equal to 70 percent of the effective range shall be applied between the input terminals. The maximum deviation of the index (pointer) from the nominal value shall be observed during the time interval specified by the manufacturer. This shall be at least 30 minutes for ranges of 1 V or less or one hour for other ranges. Maximum value of the drift shall be noted.

6.6.1 The drift shall be measured from each range.

7. INPUT IMPEDANCE

7.1 High Input Impedance (Without 50 ohms Terminations) — The input impedance shall be measured at 1 MHz with the instrument switched on. The input impedance shall be expressed in terms of its equivalent parallel resistive and reactive components. The measurements may be made with a standard RF impedance bridge.

7.2 Input VSWR (With 50 ohms Termination) — The input VSWR shall be measured in the frequency range of 500 MHz to 1 000 MHz, using the set up given in Fig. 2.

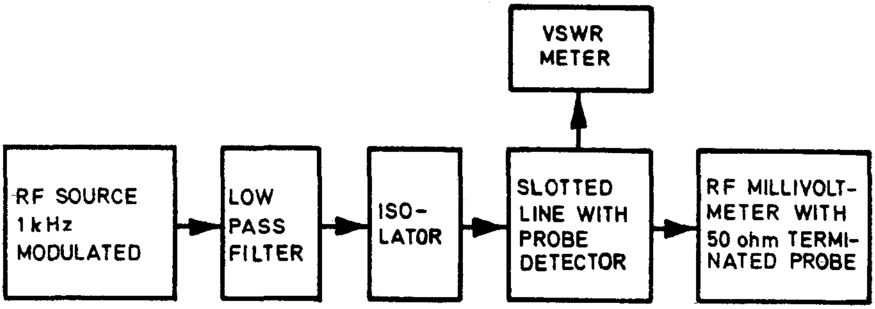
VSWR METER
RF SOURCE 1 kHz MODULATED
LOW PASS FILTER
ISO-LATOR
SLOTTED LINE WITH PROBE DETECTOR
RF MILLIVOLTMETER WITH 50 ohm TERMINATED PROBE

FIG. 2 SETUP FOR MEASURING VSWR

7.2.1 Connect at the load end of the slotted line the probe of the RF millivoltmeter which is terminated with 50 ohms.

7.2.2 Set the oscillator to 500 MHz and amplitude modulated by 1 KHz.

7.2.3 Tune the probe detector of maximum indication on the VSWR meter. Move the probe carriage till maximum deflection is observed on the VSWR meter. Set the gain control of the VSWR meter to 1·0 on VSWR scale.

7.2.4 Move the probe carriage to get the minimum deflection on the VSWR meter and the reading on the meter VSWR scale will give directly the input VSWR of the RF probe.

7.2.5 Conduct the measurement at 700 MHz and 1 000 MHz and note down the VSWR readings.

8. FREQUENCY RESPONSE

8.1 Frequency response shall be checked from 100 kHz to 1 000 MHz taking 1 MHz as reference using the setup shown in Fig. 3.

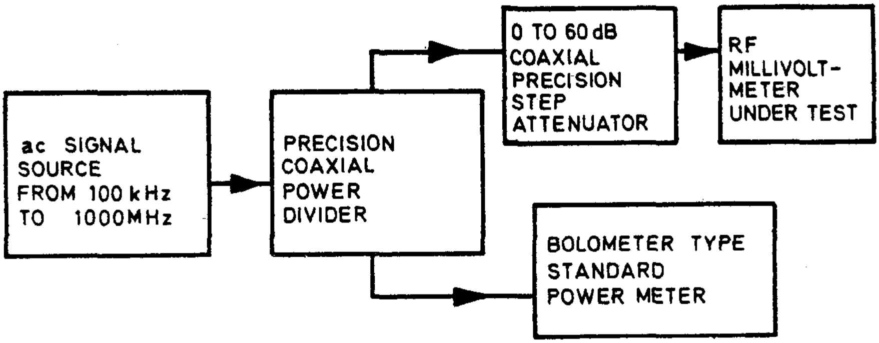
0 TO 60 dB COAXIAL PRECISION STEP ATTENUATOR
RF MILLIVOLT-METER UNDER TEST
ac SIGNAL SOURCE FROM 100 kHz TO 1000MHz
PRECISION COAXIAL POWER DIVIDER
BOLOMETER TYPE STANDARD POWER METER

FIG. 3 FREQUENCY RESPONSE

8.2 Set the range of the RF millivoltmeter for 1 volt and that of the standard Bolometer power meter to 10 mW. Keep the standard step attenuator in 0 dB position.

8.3 Set the frequency of the source for 1 MHz and adjust the output level exactly till the standard power meter accurately reads 10 mW. Note down the meter reading on the RF millivoltmeter and this will be taken as reference in this range for the measurement of frequency response.

8.4 Vary the source frequency from 100 kHz to 1 000 MHz setting always the level to maintain exactly 10 mW on the power meter. Note down the variation of the voltage reading on the RF millivoltmeter over the above frequency range. Record this variation as frequency response of the RF millivoltmeter in 1 Volt range.

8.5 Repeat the procedure in the other lower ranges keeping the step attenuator setting as shown in Table 1. In each range take the indication of the RF millivoltmeter at that particular range as reference at 1 MHz with the power meter always reading 10 mW.

TABLE 1 ATTENUATOR SETTING

RF MILLIVOLTMETER RANGE (1)	STEP ATTENUATOR SETTING (2)
1 Volt	0 dB
300 mV	10 dB
100 mV	20 dB
30 mV	30 dB
10 mV	40 dB
3 mV	50 dB
1 mV	60 dB

9. DAMPING

9.1 The damping of a voltmeter is determined by the measurements of the overshoot and settling time. After preliminary adjustments, a low frequency ac voltage corresponding to a steady deflection equal to 70 percent of the upper limit of effective range shall then be suddenly applied between the input terminals. Under these conditions, the overshoot shall not exceed the upper limit of the effective range. The time required for the index to attain its final steady position, within 1·5 percent of the upper limit of the effective range, shall be measured.

10. OVERLOAD CAPABILITY

10.1 The RF probe of the millivoltmeter should be able to take at least 10 volt at 1 MHz and about 100 volts dc without damaging the characteristics.

11. INFLUENCE OF EXTERNAL MAGNETIC FIELD

11.1 The values shall be agreed between the manufacturer and the user.

12. INFLUENCE OF EXTERNAL ELECTRIC FIELD

12.1 The values shall be agreed between the manufacturer and the user.

13. INFLUENCE OF EXTERNAL RF ELECTROMAGNETIC FIELD

13.1 The values shall be agreed between the manufacturer and the user.